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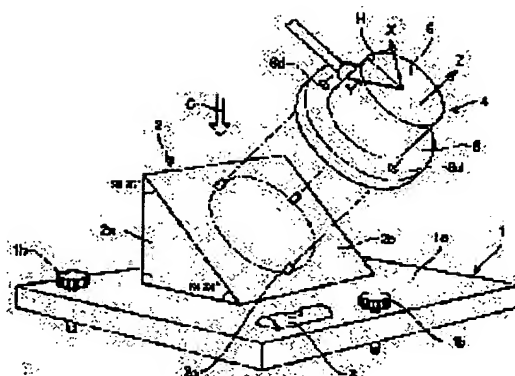
SEKI ATSUSHI

(54) 3-AXIS ACCELEROMETER CALIBRATION JIG

(57)Abstract:

PROBLEM TO BE SOLVED: To rapidly perform calibration work by providing an accelerometer attaching surface which forms a specified angle for the flat plane orthogonal to the gravitational acceleration direction to allow easier attaching work of an accelerometer to a calibration jig.

SOLUTION: An attaching surface 2b, forming an angle $\tan^{-1} (21/2)$ (about 54.74°) against a flat plane 1a orthogonal to the gravitational acceleration direction, is provided to a block 2. On the attaching surface 2b, a three axis accelerometer 4 is so attached that gravitational acceleration equal to X-direction sensitive axis and Y-direction sensitive axis of the accelerometer 4 acts. Then, on each X, Y and Z axis acceleration sensor, the identical acceleration component (about 57.4% of gravitational acceleration G) due to the gravitational acceleration G acts. Thus, by adjusting a gain of an amplifier, a display, etc., with a calibration device so that the output voltage of each axis acceleration sensor displays the identical value, sensitivity calibration can be performed by attaching a calibration jig to the accelerometer 4 only once.



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CLAIMS

[Claim(s)]

[Claim 1] the clamp face where an include angle becomes $\tan^{-1} (21/2)$ to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when performing the sensitivity calibration of an accelerometer three shaft using gravitational acceleration, and intersects perpendicularly with the gravitational-acceleration direction -- having -- this clamp face -- said three shaft characterized by said thing [attaching an accelerometer three shaft] so that gravitational acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer may act three shaft -- an accelerometer -- the fixture for proofreading.

[Claim 2] the clamp face where an include angle becomes $\tan^{-1} (21/2)$ to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when performing the sensitivity calibration of an accelerometer three shaft using excitation equipment, and intersects perpendicularly with the acceleration direction -- having -- this clamp face -- said three shaft characterized by said thing [attaching an accelerometer three shaft] so that acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer may act three shaft -- an accelerometer -- the fixture for proofreading.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] three shaft which has the sensitive axis with which this invention intersects perpendicularly mutually and which is used on the occasion of the sensitivity calibration of an accelerometer three shaft -- an accelerometer -- it is related with the fixture for proofreading.

[0002]

[Description of the Prior Art] three conventional shaft -- an accelerometer -- as the fixture for proofreading -- the accelerometer of rectangular cross 3 shaft (X, Y, Z), for example, a servo, -- when performing the sensitivity calibration of an accelerometer using gravitational acceleration, in order to make the direction of a sensitive axis in agreement in the gravitational acceleration direction, the fixture for proofreading which refixes an accelerometer for every sensitive axis is known. moreover, a piezo-electric form -- also when performing the sensitivity calibration of an accelerometer using excitation equipment, in order to make the direction of a sensitive axis in agreement in the acceleration direction, the fixture for proofreading which refixes an accelerometer for every sensitive axis is known.

[0003] Namely, make the fixture for proofreading fix an accelerometer, and although the sensitivity calibration of three shafts is performed, sensitivity settling is performed so that it may become predetermined sensibility, so that the acceleration direction may be in agreement with the sensitive axis of a Z-axis acceleration sensor first. Subsequently, make an accelerometer fix to the fixture for proofreading, and sensitivity settling is performed so that it may become predetermined sensibility, so that the acceleration direction may be in agreement with the sensitive axis of an X-axis acceleration sensor. Furthermore, an accelerometer is made to fix to the fixture for proofreading, and sensitivity settling is performed so that it may become predetermined sensibility, so that the acceleration direction may be in agreement with the sensitive axis of a Z-axis acceleration sensor.

[0004]

[Problem(s) to be Solved by the Invention] three conventional shaft -- an accelerometer -- in the fixture for proofreading, whenever it performed sensitivity settling of each shaft, the accelerometer had to be refixed, attachment of the acceleration to the fixture for proofreading was complicated, and it was difficult to perform a sensitivity calibration quickly.

[0005] three shaft with which the place which this invention is made in view of such a trouble that a Prior art has, and is made into the purpose can perform the sensitivity calibration of an accelerometer three shaft by the attachment to 1 time of the fixture for proofreading -- an accelerometer -- it is going to offer the fixture for proofreading.

[0006]

[Means for Solving the Problem] the clamp face where an include angle becomes $\tan^{-1}(21/2)$ to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when invention of claim 1 performs the sensitivity calibration of an accelerometer three shaft using gravitational acceleration, and intersects perpendicularly with the gravitational-acceleration direction that the above-mentioned technical problem should be solved -- having -- this clamp

face -- said -- as gravitational acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer acts three shaft, it is said thing which attaches an accelerometer three shaft.

[0007] the clamp face where an include angle becomes $\tan^{-1}(21/2)$ to the flat surface which is said fixture for proofreading which fixes an accelerometer three shaft when invention of claim 2 performs the sensitivity calibration of an accelerometer three shaft using excitation equipment, and intersects perpendicularly with the acceleration direction -- having -- this clamp face -- said -- as acceleration equal to the direction sensitive axis of X and the direction sensitive axis of Y of an accelerometer acts three shaft, it is said thing which attaches an accelerometer three shaft.

[0008]

[Embodiment of the Invention] The gestalt of operation of this invention is explained based on an accompanying drawing below. three shaft which drawing 1 requires for invention of claim 1 here -- an accelerometer -- three shaft for which the perspective view of the fixture for proofreading and drawing 2 spend for the configuration explanatory view of an accelerometer, and drawing 3 spends three shaft to invention of claim 1 -- an accelerometer -- three shaft for which the operation explanatory view of the fixture for proofreading and drawing 4 spend for the outline block diagram of the calibrating apparatus of an accelerometer, and drawing 5 spends three shaft to invention of claim 2 -- an accelerometer -- three shaft which the perspective view of the fixture for proofreading and drawing 6 require for invention of claim 2 -- an accelerometer -- it is the operation explanatory view of the fixture for proofreading.

[0009] three shaft concerning invention of claim 1 -- an accelerometer -- the fixture for proofreading consists of block 2 laid in top-face 1a of the metal pedestal 1 and a pedestal 1 as shown in drawing 1, and adjusting-screw 1b for making the horizontal plane which intersects perpendicularly with the gravitational acceleration direction at top-face 1a form is prepared in the pedestal 1. In addition, 3 is level which checks that top-face 1a of a pedestal 1 becomes a horizontal plane.

[0010] Block 2 is formed in the right-angle triangle pole with a metallic material (for example, aluminum), and the include angle of each vertical angle of the right triangle which are top-face 2a of the right-angle triangle pole and a base becomes about 35.26 degrees by 90 degrees and $\tan^{-1}(2-1/2)$, and has become about 54.74 degrees by $\tan^{-1}(21/2)$, respectively. In addition, about the reason for having set up the include angle of each vertical angle as mentioned above, it mentions later.

[0011] And top-face 1a of a pedestal 1 is touched in the side face of the right-angle triangle pole in which a 35.26-degree vertical angle counters, and the block 2 is laid in top-face 1a of a pedestal 1. Moreover, three pin 2c which carries out positioning immobilization of the accelerometer 4 three shafts protrudes on clamp-face 2b which is the side face of the right-angle triangle pole in which a 90-degree vertical angle counters perpendicularly. Therefore, clamp-face 2b will form about 54.74-degree flat surface to about 35.26 degrees and top-face 1a of a pedestal 1 to the gravitational acceleration direction.

[0012] the servo which an accelerometer 4 makes a sensitive axis intersect perpendicularly mutually, arranges the X-axis acceleration sensor 5, the Y-axis acceleration sensor 6, and the Z-axis acceleration sensor 7 in top-face 8a of the disc-like base 8 as shown in drawing 2, and it puts the cylinder-like case 9 on top-face 8a of the base 8, is constituted three shaft, and has sensibility also in gravitational acceleration (DC field) -- it is an accelerometer. in addition, for example, the strain gage type which has the sensibility of DC field as an accelerometer 4 three shafts -- an accelerometer may be used.

[0013] The X-axis acceleration sensor 5 and the Y-axis acceleration sensor 6 are arranged in parallel [those sensitive axes] with top-face 8a of the base 8, and the Z-axis acceleration sensor 7 is arranged at right angles [the sensitive axis] to top-face 8a of the base 8. Moreover, 8d of mounting holes which fit in pin 2c, are made to stick base 8c of the base 8 to clamp-face 2b of block 2, and are fixed to block 2 is formed in flange 8b of the base 8.

[0014] If an accelerometer 4 is fixed to clamp-face 2b of block 2 three shaft, in the X-axis acceleration sensor 5 and the Y-axis acceleration sensor 6, those sensitive axes will become

parallel to clamp-face 2b, and, as for the Z-axis acceleration sensor 7, the sensitive axis will become perpendicular to clamp-face 2b.

[0015] three shaft concerning invention of claim 1 constituted as mentioned above -- an accelerometer -- an operation of the fixture for proofreading is explained. As shown in drawing 1 R> 1, pin 2c is fitted into 8d of mounting holes, and an accelerometer 4 is fixed to block 2 three shaft. At this time, as shown in drawing 3 (a), gravitational acceleration G, clamp-face 2b of block 2, and the include angle to make are set to theta. Then, a component parallel to clamp-face 2b of the block 2 of gravitational acceleration G is set to $G \cdot \cos \theta$, and a perpendicular component is set to $G \cdot \sin \theta$.

[0016] And as shown in drawing 3 (b), an accelerometer 4 is fixed to clamp-face 2b of block 2 three shafts so that it may be in agreement with the shaft H with which the direction of $G \cdot \cos \theta$ which is the component of gravitational acceleration G divides into two equally the angle (90 degrees) which direction sensitive-axis of X 5a of an accelerometer 4 and direction sensitive-axis of Y 6a make three shafts.

[0017] Therefore, $G \cdot \sin \theta$ which is a component perpendicular to clamp-face 2b acts on Z direction sensitive-axis 7a, and 45 degree of $G \cdot \cos \theta$ act on direction sensitive-axis of X 5a, and direction sensitive-axis of Y 6a. Here, it asks for the include angle theta for giving equivalent acceleration to each sensitive axes 5a, 6a, and 7a of X-Y-Z.

[0018] Namely, what is necessary is just to ask for the include angle theta to which $G \cdot \sin \theta$ which is 45 degree of $G \cdot \cos \theta$ which is the component of gravitational acceleration G which acts on direction sensitive-axis of X 5a and direction sensitive-axis of Y 6a, and the component of gravitational acceleration G which acts on Z direction sensitive-axis 7a becomes equal, as shown in drawing 3. Therefore, it is [0019] from 45 degree = $G \cdot \sin \theta$ of $G \cdot \cos \theta$ -- $\cos \theta$] theta. It becomes $\theta = \tan^{-1} (2^{-1/2})$, a next door, and about 35.26 degrees.

[0020] Moreover, it is [0021] when top-face 1a of a pedestal 1, clamp-face 2b of block 2, and the include angle to make are set to alpha (90 degree - theta). It becomes $\alpha = \tan^{-1} (2^{1/2})$, a next door, and about 54.74 degrees.

[0022] three shaft equipped with the block 2 which has the above include angles theta (about 35.26 degrees) and alpha (about 54.74 degrees) -- an accelerometer -- the sensitivity calibration of an accelerometer 4 is performed three shafts by using gravitational acceleration G using the fixture for proofreading. Then, the same acceleration component (about 57.7% of the gravitational acceleration G) by gravitational acceleration G acts on each axial acceleration sensors 5, 6, and 7 of X-Y-Z, respectively.

[0023] therefore, three shaft as shown in drawing 4 -- an accelerometer -- if a calibrating apparatus adjusts gain, such as amplifier 8 and a drop 9, etc. so that the output voltage of each axial acceleration sensors 5, 6, and 7 of X-Y-Z may display the same value (about 565 Gal), the sensitivity calibration of each axial acceleration sensors 5, 6, and 7 can carry out by attaching an accelerometer 4 in the fixture for proofreading only once three shafts.

[0024] three shaft concerning invention of claim 2 -- an accelerometer -- the fixture for proofreading consists of block 12 laid in top-face 11a of the metal pedestal 11 and a pedestal 11 as shown in drawing 5, and the **** 14 for immobilization fixed to the shaking table 13 of excitation equipment is formed in the pedestal 11. In addition, A expresses the magnitude of acceleration while showing the direction of excitation by excitation equipment.

[0025] Block 12 is formed in the right-angle triangle pole with a metallic material (for example, aluminum), and the include angle of each vertical angle of the right triangle which are top-face 12a of the right-angle triangle pole and a base becomes about 54.74 degrees by 90 degrees and $\tan^{-1} (2^{1/2})$, and has become about 35.26 degrees by $\tan^{-1} (2^{-1/2})$, respectively. In addition, about the reason for having set up the include angle of each vertical angle as mentioned above, it mentions later.

[0026] And top-face 11a of a pedestal 11 is touched in the side face of the right-angle triangle pole in which a 54.74-degree vertical angle counters, and the block 12 is laid in top-face 11a of a pedestal 11. Moreover, three pin 12c which carries out positioning immobilization of the accelerometer 14 three shafts protrudes on clamp-face 12b which is the side face of the right-angle triangle pole in which a 90-degree vertical angle counters perpendicularly. Therefore,

clamp-face 12b will form about 35.26-degree flat surface to top-face 11a of excitation of a pedestal 11, i.e., the direction.

[0027] the servo which has sensibility also in the gravitational acceleration (DC field) which is set as the object of a sensitivity calibration, and which shows an accelerometer 14 to drawing 2 three shaft -- the piezo-electric type which has neither an accelerometer nor the sensibility in gravitational acceleration (DC field) -- it is an accelerometer etc.

[0028] three shaft concerning invention of claim 2 constituted as mentioned above -- an accelerometer -- an operation of the fixture for proofreading is explained. As shown in drawing 5 R> 5, pin 12c is fitted into 18d of mounting holes, and an accelerometer 14 is fixed to block 12 three shaft. At this time, as shown in drawing 6 (a), acceleration A, clamp-face 12b of block 12, and the include angle to make are set to beta. Then, a component parallel to clamp-face 12b of the block 12 of acceleration A is set to $A \cdot \cos \beta$, and a perpendicular component is set to $A \cdot \sin \beta$.

[0029] And as shown in drawing 6 (b), an accelerometer 14 is fixed to clamp-face 12b of block 12 three shafts so that it may be in agreement with the shaft H with which the direction of $A \cdot \cos \beta$ which is the component of acceleration A divides into two equally the angle (90 degrees) which direction sensitive-axis of X 5a of an accelerometer 14 and direction sensitive-axis of Y 6a make three shafts.

[0030] Therefore, $A \cdot \sin \beta$ which is a component perpendicular to clamp-face 12b acts on Z direction sensitive-axis 7a, and 45 degree of $A \cdot \cos \beta \cdot \cos$ act on direction sensitive-axis of X 5a, and direction sensitive-axis of Y 6a. Here, it asks for the include angle beta for giving equivalent acceleration to each sensitive axes 5a, 6a, and 7a of X-Y-Z.

[0031] Namely, what is necessary is just to ask for the include angle beta to which $A \cdot \sin \beta$ which is 45 degree of $A \cdot \cos \beta \cdot \cos$ which is the component of acceleration A which acts on direction sensitive-axis of X 5a and direction sensitive-axis of Y 6a, and the component of acceleration A which acts on Z direction sensitive-axis 7a becomes equal, as shown in drawing 6. Therefore, it is [0032] from 45 degree $= A \cdot \sin$ [of $A \cdot \cos \beta \cdot \cos$] beta. It becomes $\beta = \tan^{-1} (2^{-1/2})$, a next door, and about 35.26 degrees.

[0033] three shaft equipped with the block 12 which has the above include angles beta (about 35.26 degrees) -- an accelerometer -- the sensitivity calibration of an accelerometer 14 is performed three shaft by using excitation equipment using the fixture for proofreading. Then, the same acceleration component (about 57.7% of the acceleration A) by acceleration A acts on each axial acceleration sensors 5, 6, and 7 of X-Y-Z, respectively.

[0034] Therefore, if a calibrating apparatus as shown in drawing 4 adjusts gain, such as amplifier 8 and a drop 9, etc. so that the output voltage of each axial acceleration sensors 5, 6, and 7 of X-Y-Z may display the same value, the sensitivity calibration of each axial acceleration sensors 5, 6, and 7 can carry out by attaching an accelerometer 14 in the fixture for proofreading only once three shafts.

[0035] In addition, although excitation equipment horizontal to drawing 5 was shown, as long as it uses the fixture for proofreading which has the clamp face where an include angle becomes about 35.26 degrees to the acceleration direction, you may be vertical excitation equipment.

[0036] Moreover, if it is set up so that the gravitational acceleration direction and the direction A of excitation of the excitation equipment shown in drawing 5 may cross at right angles Namely, if clamp-face 12b forms the include angle of $\tan^{-1} (2^{1/2})$ (about 54.74 degrees) to the flat surface which intersects perpendicularly with the excitation acceleration direction the servo which has sensibility also in DC field -- if the sensitivity calibration using the gravitational acceleration G of an accelerometer is performed, the component of the following gravitational acceleration G will act on each axial acceleration sensors 5, 6, and 7.

[0037] If gravitational acceleration G is set to 980Gal, the component of gravitational acceleration G which acts on the Z-axis acceleration sensor 7 will be set to $980 \times \sin(54.74 \text{ degrees}) = 800$, and the component of gravitational acceleration G which acts on the X-axis acceleration sensor 5 and the Y-axis acceleration sensor 6 will be set to $980 \times \cos(54.74 \text{ degrees}) \times \cos(45 \text{ degrees}) = 400$. That is, the component of the good gravitational acceleration G of the end called 800Gal will act on 400Gal and the Z-axis acceleration sensor 7 at the X-axis

acceleration sensor 5 and the Y-axis acceleration sensor 6.

[0038] Therefore, the sensitivity calibration using gravitational acceleration G and the acceleration A of excitation equipment can carry out by performing attachment to the fixture for proofreading of an accelerometer 14 only once three shafts.

[0039] Even when performing the sensitivity calibration of an accelerometer 4 three shaft using gravitational acceleration G If accelerometers 4 and 14 are fixed to the clamp face where an include angle becomes $\tan^{-1} (2-1/2)$ (about 35.26 degrees) to the acceleration direction three shaft like the above even when performing the sensitivity calibration of an accelerometer 14 three shaft using excitation equipment The same acceleration component (gravitational acceleration G or about 57.7% of the acceleration A) acts on each axial acceleration sensors 5, 6, and 7 of X-Y-Z.

[0040] Moreover, when performing the sensitivity calibration of an accelerometer 4 three shaft using gravitational acceleration G, or when performing the sensitivity calibration of an accelerometer 14 three shaft using excitation equipment, since blocks 2 and 12 can be formed in the same configuration, they can be common-use-ized by the method of installation or immobilization in top-face 1a of a pedestal 1, or a shaking table 13.

[0041] that is, when touching top-face 1a of a pedestal 1 in the side face in which the 35.26-degree vertical angle of the top faces 2a and 12a of the blocks 2 and 12 which are right angled triangles counters and laying the block 2 in top-face 1a of a pedestal 1, gravitational acceleration G was used -- the sensitivity calibration of an accelerometer 4 can be performed three shaft. excitation equipment was used, when the shaking table 13 was touched in the side face in which a 54.74-degree vertical angle counters, on the other hand and the block 2 was fixed to the shaking table 13 -- the sensitivity calibration of an accelerometer 14 can be performed three shaft.

[0042] moreover, three shaft shown in drawing 1 -- an accelerometer -- if the fixture for proofreading is fixed to vertical excitation equipment and it excites in the gravitational acceleration direction when performing the sensitivity calibration of an accelerometer 4 three shaft using the fixture for proofreading, the sensitivity calibration using gravitational acceleration G and the acceleration of excitation equipment can be performed by performing attachment to the fixture for proofreading of an accelerometer 4 only once three shafts.

[0043] moreover, three shaft with which the sensitivity calibration of each axial acceleration sensors 5, 6, and 7 of X-Y-Z has already been performed by each axial independent one and which takes three shaft at this invention in the case of accelerometers 4 and 14 -- an accelerometer -- it becomes possible by performing a sensitivity calibration using the fixture for proofreading to get to know the precision with a group of each axial acceleration sensors 5, 6, and 7.

[0044] Moreover, if the acceleration sensor which has a polarity in each shaft of X and Y-Z is used, the attachment condition of an acceleration sensor can be checked from the phase relation of the output signal of each acceleration sensor.

[0045]

[Effect of the Invention] Since the sensitivity calibration of an accelerometer can be performed to 3 shaft coincidence three shafts according to this invention if an accelerometer is fixed to the clamp face of the fixture for proofreading three shafts as explained above, the attachment to the fixture for proofreading of an accelerometer can be managed at once three shafts, and speeding up of the sensitivity calibration of an accelerometer can be attained three shafts.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] three shaft concerning invention of claim 1 -- an accelerometer -- the perspective view of the fixture for proofreading

[Drawing 2] For the configuration explanatory view of an accelerometer, and (a), the plot plan of an acceleration sensor and (b) are the side elevation of an accelerometer three shaft three shaft.

[Drawing 3] three shaft concerning invention of claim 1 -- an accelerometer -- the operation explanatory view of the fixture for proofreading, drawing in which (a) shows a gravitational acceleration component perpendicular to the clamp face of an accelerometer, and parallel three shaft, and drawing in which (b) shows the decomposition condition to X and the Y-axis of a gravitational acceleration component parallel to the clamp face of an accelerometer three shaft

[Drawing 4] It is the outline block diagram of the calibrating apparatus of an accelerometer three shaft.

[Drawing 5] three shaft concerning invention of claim 2 -- an accelerometer -- the perspective view of the fixture for proofreading

[Drawing 6] three shaft concerning invention of claim 2 -- an accelerometer -- the operation explanatory view of the fixture for proofreading, drawing in which (a) shows an acceleration component perpendicular to the clamp face of an accelerometer, and parallel three shaft, and drawing in which (b) shows the decomposition condition to X and the Y-axis of an acceleration component parallel to the clamp face of an accelerometer three shaft

[Description of Notations]

1 11 [-- The top face of a block 2b, 12b / -- A clamp face, 3 / -- 4 Level, 14 / -- It is an accelerometer and 5 three shafts. / -- An X-axis acceleration sensor, the direction sensitive axis of 5 a--X 6 / -- A Y-axis acceleration sensor, the direction sensitive axis of 6 a--Y 7 / -- Z-axis acceleration sensor, 7a / -- A Z direction sensitive axis, 13 / -- A shaking table, 14 / -- **** for immobilization.] -- A pedestal, 1a, 11a -- 2 The top face of a pedestal, 12 -- A block, 2a, 12a

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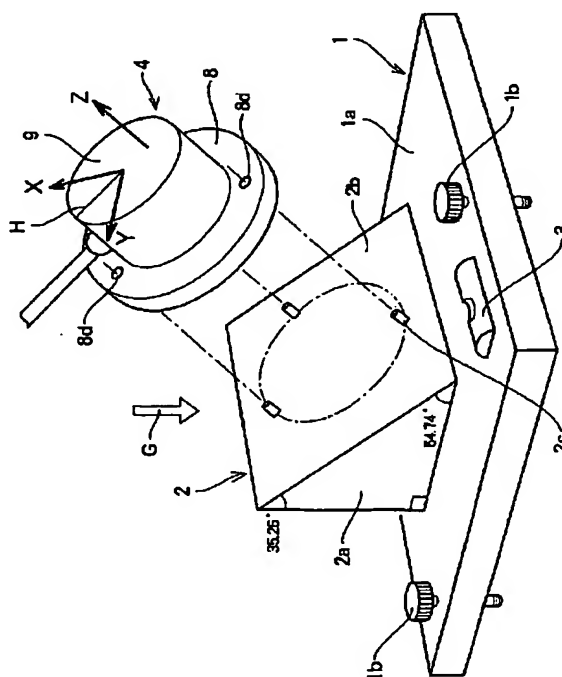
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(54) 【発明の名称】 3軸加速度計校正用治具

(57) 【要約】

【課題】 各軸の感度調整を行う毎に、3軸加速度計を校正用治具に固定し直さなければならない。

【解決手段】 重力加速度Gを利用して3軸加速度計4の感度校正を行う場合に3軸加速度計4を固定する校正用治具であって、重力加速度方向と直交する平面1aに対して、角度が $\tan^{-1}(2^{1/2})$ (約54.74°)となる取付面2bを備え、この取付面2bに3軸加速度計4のX方向受感軸とY方向受感軸に等しい重力加速度が作用するように3軸加速度計4を取付ける。



【特許請求の範囲】

【請求項1】 重力加速度を利用して3軸加速度計の感度校正を行う場合に前記3軸加速度計を固定する校正用治具であって、重力加速度方向と直交する平面に対して、角度が $\tan^{-1}(2^{1/2})$ となる取付面を備え、この取付面に前記3軸加速度計のX方向受感軸とY方向受感軸に等しい重力加速度が作用するように前記3軸加速度計を取付けることを特徴とする3軸加速度計校正用治具。

【請求項2】 加振装置を利用して3軸加速度計の感度校正を行う場合に前記3軸加速度計を固定する校正用治具であって、加速度方向と直交する平面に対して、角度が $\tan^{-1}(2^{1/2})$ となる取付面を備え、この取付面に前記3軸加速度計のX方向受感軸とY方向受感軸に等しい加速度が作用するように前記3軸加速度計を取付けることを特徴とする3軸加速度計校正用治具。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、互いに直交する受感軸を有する3軸加速度計の感度校正に際して用いる3軸加速度計校正用治具に関する。

【0002】

【従来の技術】従来の3軸加速度計校正用治具としては、直交3軸(X、Y、Z)の加速度計、例えばサーボ加速度計の感度校正を重力加速度を利用して行う場合に、受感軸方向を重力加速度方向に一致させるため、各受感軸毎に加速度計を固定し直す校正用治具が知られている。また、圧電形加速度計の感度校正を加振装置を利用して行う場合にも、受感軸方向を加速度方向に一致させるため、各受感軸毎に加速度計を固定し直す校正用治具が知られている。

【0003】即ち、3軸の感度校正を行うのに、先ずZ軸加速度センサの受感軸に加速度方向が一致するように加速度計を校正用治具に固定させて所定の感度になるように感度調整を行い、次いでX軸加速度センサの受感軸に加速度方向が一致するように加速度計を校正用治具に固定させて所定の感度になるように感度調整を行い、更にZ軸加速度センサの受感軸に加速度方向が一致するように加速度計を校正用治具に固定させて所定の感度になるように感度調整を行う。

【0004】

【発明が解決しようとする課題】従来の3軸加速度計校正用治具においては、各軸の感度調整を行う毎に、加速度計を固定し直さなければならず、校正用治具への加速度の取付作業が煩雑であり、感度校正を迅速に行うのが困難であった。

【0005】本発明は、従来の技術が有するこのような問題点を鑑みてなされたものであり、その目的とするところは、1回の校正用治具への取付作業で3軸加速度計の感度校正が行える3軸加速度計校正用治具を提供しよ

うとするものである。

【0006】

【課題を解決するための手段】上記課題を解決すべく請求項1の発明は、重力加速度を利用して3軸加速度計の感度校正を行う場合に前記3軸加速度計を固定する校正用治具であって、重力加速度方向と直交する平面に対して、角度が $\tan^{-1}(2^{1/2})$ となる取付面を備え、この取付面に前記3軸加速度計のX方向受感軸とY方向受感軸に等しい重力加速度が作用するように前記3軸加速度計を取付けるものである。

【0007】請求項2の発明は、加振装置を利用して3軸加速度計の感度校正を行う場合に前記3軸加速度計を固定する校正用治具であって、加速度方向と直交する平面に対して、角度が $\tan^{-1}(2^{1/2})$ となる取付面を備え、この取付面に前記3軸加速度計のX方向受感軸とY方向受感軸に等しい加速度が作用するように前記3軸加速度計を取付けるものである。

【0008】

【発明の実施の形態】以下に本発明の実施の形態を添付図面に基いて説明する。ここで、図1は請求項1の発明に係る3軸加速度計校正用治具の斜視図、図2は3軸加速度計の構成説明図、図3は請求項1の発明に係る3軸加速度計校正用治具の作用説明図、図4は3軸加速度計の校正装置の概要ブロック図、図5は請求項2の発明に係る3軸加速度計校正用治具の斜視図、図6は請求項2の発明に係る3軸加速度計校正用治具の作用説明図である。

【0009】請求項1の発明に係る3軸加速度計校正用治具は、図1に示すように、金属製の基台1と、基台1の上面1aに載置するブロック2からなり、基台1には上面1aに重力加速度方向と直交する水平面を形成させるための調整ねじ1bが設けられている。なお、3は基台1の上面1aが水平面になるのを確認する水準器である。

【0010】ブロック2は、金属材料(例えば、アルミニウム)で直角三角柱に形成され、直角三角柱の上面2a及び底面である直角三角形の各頂角の角度は、夫々 90° 、 $\tan^{-1}(2^{-1/2})$ で約 35.26° 、 $\tan^{-1}(2^{1/2})$ で約 54.74° となっている。なお、各頂角の角度を上述のように設定した理由については後述する。

【0011】そして、 35.26° の頂角が対向する直角三角柱の側面を基台1の上面1aに接して、ブロック2は基台1の上面1aに載置されている。また、 90° の頂角が対向する直角三角柱の側面である取付面2bには、3軸加速度計4を位置決め固定する3本のピン2cが垂直に突設されている。従って、取付面2bは、重力加速度方向に対して約 35.26° 、基台1の上面1aに対して約 54.74° の平面を形成することになる。

【0012】3軸加速度計4は、図2に示すように、受

感軸を互いに直交させてX軸加速度センサ5、Y軸加速度センサ6、Z軸加速度センサ7を円盤状のベース8の上面8aに配設し、ベース8の上面8aに円柱状のケース9を被せて構成され、重力加速度(DC領域)においても感度を有するサーボ加速度計である。なお、3軸加速度計4としては、DC領域の感度を有する、例えばストレインゲージ式加速度計でもよい。

【0013】X軸加速度センサ5及びY軸加速度センサ6は、それらの受感軸がベース8の上面8aと平行に配設され、Z軸加速度センサ7は、その受感軸がベース8の上面8aと垂直に配設されている。また、ベース8のフランジ部8bには、ピン2cを嵌合してベース8の底面8cをブロック2の取付面2bに密着させてブロック2に固定する取付孔8dが形成されている。

【0014】3軸加速度計4をブロック2の取付面2bに固定すると、X軸加速度センサ5及びY軸加速度センサ6は、それらの受感軸が取付面2bに対して平行になり、Z軸加速度センサ7は、その受感軸が取付面2bに対して垂直になる。

【0015】以上のように構成した請求項1の発明に係る3軸加速度計校正用治具の作用について説明する。図1に示すように、ピン2cを取付孔8dに嵌合して3軸加速度計4をブロック2に固定する。この時、図3

(a)に示すように、重力加速度Gとブロック2の取付面2bとなす角度を θ とする。すると、重力加速度Gのブロック2の取付面2bに平行な成分は $G \cdot \cos \theta$ 、垂直な成分は $G \cdot \sin \theta$ となる。

【0016】そして、図3(b)に示すように、重力加速度Gの成分である $G \cdot \cos \theta$ の方向が、3軸加速度計4のX方向受感軸5aとY方向受感軸6aのなす角(90°)を2等分する軸Hに一致するように、3軸加速度計4がブロック2の取付面2bに固定される。

【0017】従って、Z方向受感軸7aには、取付面2bに垂直な成分である $G \cdot \sin \theta$ が作用し、X方向受感軸5a及びY方向受感軸6aには、 $G \cdot \cos \theta \cdot \cos 45^\circ$ が作用する。ここで、X・Y・Zの各受感軸5a、6a、7aに同等な加速度を与えるための角度 θ を求める。

【0018】即ち、図3に示すように、X方向受感軸5a及びY方向受感軸6aに作用する重力加速度Gの成分である $G \cdot \cos \theta \cdot \cos 45^\circ$ と、Z方向受感軸7aに作用する重力加速度Gの成分である $G \cdot \sin \theta$ が等しくなる角度 θ を求めればよい。従って、 $G \cdot \cos \theta \cdot \cos 45^\circ = G \cdot \sin \theta$ より、

【0019】 $\theta = \tan^{-1}(2^{-1/2})$ 、となり、約35.26°となる。

【0020】また、基台1の上面1aとブロック2の取付面2bとなす角度を $\alpha(90^\circ - \theta)$ とすると、

【0021】 $\alpha = \tan^{-1}(2^{1/2})$ 、となり、約54.74°となる。

【0022】以上のような角度 θ (約35.26°)、 α (約54.74°)を有するブロック2を備えた3軸加速度計校正用治具を用いて重力加速度Gを利用することにより、3軸加速度計4の感度校正を行う。すると、X・Y・Zの各軸加速度センサ5、6、7には、夫々重力加速度Gによる同一の加速度成分(重力加速度Gの約57.7%)が作用する。

【0023】従って、図4に示すような3軸加速度計校正装置で、X・Y・Zの各軸加速度センサ5、6、7の出力電圧が同一の値(約565Ga1)を表示するように増幅器8や表示器9などのゲイン等を調整すれば、各軸加速度センサ5、6、7の感度校正が、3軸加速度計4を校正用治具に1回だけ取付けることにより実施できる。

【0024】請求項2の発明に係る3軸加速度計校正用治具は、図5に示すように、金属製の基台11と、基台11の上面11aに載置するブロック12からなり、基台11には加振装置の加振台13に固定する固定用ねじ14が設けられている。なお、Aは加振装置による加振方向を示すと共に、加速度の大きさを表す。

【0025】ブロック12は、金属材料(例えば、アルミニウム)で直角三角柱に形成され、直角三角柱の上面12a及び底面である直角三角形の各頂角の角度は、夫々90°、 $\tan^{-1}(2^{1/2})$ で約54.74°、 $\tan^{-1}(2^{-1/2})$ で約35.26°となっている。なお、各頂角の角度を上述のように設定した理由については後述する。

【0026】そして、54.74°の頂角が対向する直角三角柱の側面を基台11の上面11aに接して、ブロック12は基台11の上面11aに載置されている。また、90°の頂角が対向する直角三角柱の側面である取付面12bには、3軸加速度計14を位置決め固定する3本のピン12cが垂直に突設されている。従って、取付面12bは、基台11の上面11a、即ち加振方向に対して約35.26°の平面を形成することになる。

【0027】感度校正の対象となる3軸加速度計14は、図2に示す重力加速度(DC領域)においても感度を有するサーボ加速度計や、重力加速度(DC領域)における感度を有さない圧電式加速度計などである。

【0028】以上のように構成した請求項2の発明に係る3軸加速度計校正用治具の作用について説明する。図5に示すように、ピン12cを取付孔18dに嵌合して3軸加速度計14をブロック12に固定する。この時、図6(a)に示すように、加速度Aとブロック12の取付面12bとなす角度を β とする。すると、加速度Aのブロック12の取付面12bに平行な成分は $A \cdot \cos \beta$ 、垂直な成分は $A \cdot \sin \beta$ となる。

【0029】そして、図6(b)に示すように、加速度Aの成分である $A \cdot \cos \beta$ の方向が、3軸加速度計14のX方向受感軸5aとY方向受感軸6aのなす角(9

0°)を2等分する軸Hに一致するように、3軸加速度計14がブロック12の取付面12bに固定される。

【0030】従って、Z方向受感軸7aには、取付面12bに垂直な成分である $A \cdot \sin \beta$ が作用し、X方向受感軸5a及びY方向受感軸6aには、 $A \cdot \cos \beta \cdot \cos 45^\circ$ が作用する。ここで、X・Y・Zの各受感軸5a、6a、7aに同等な加速度を与えるための角度 β を求める。

【0031】即ち、図6に示すように、X方向受感軸5a及びY方向受感軸6aに作用する加速度Aの成分である $A \cdot \cos \beta \cdot \cos 45^\circ$ と、Z方向受感軸7aに作用する加速度Aの成分である $A \cdot \sin \beta$ が等しくなる角度 β を求めればよい。従って、 $A \cdot \cos \beta \cdot \cos 45^\circ = A \cdot \sin \beta$ より、

【0032】 $\beta = \tan^{-1}(2^{1/2})$ 、となり、約35.26°となる。

【0033】以上のような角度 β (約35.26°)を有するブロック12を備えた3軸加速度計校正用治具を用いて加振装置を利用することにより3軸加速度計14の感度校正を行う。すると、X・Y・Zの各軸加速度センサ5、6、7には、夫々加速度Aによる同一の加速度成分(加速度Aの約57.7%)が作用する。

【0034】従って、図4に示すような校正装置で、X・Y・Zの各軸加速度センサ5、6、7の出力電圧が同一の値を表示するように増幅器8や表示器9などのゲイン等を調整すれば、各軸加速度センサ5、6、7の感度校正が、3軸加速度計14を校正用治具に1回だけ取付けることにより実施できる。

【0035】なお、図5には水平方向の加振装置を示したが、加速度方向に対して角度が、約35.26°となる取付面を有する校正用治具を用いれば、垂直方向の加振装置であってもよい。

【0036】また、図5に示す加振装置の加振方向Aが重力加速度方向と直交するように設定されていれば、即ち取付面12bが加振加速度方向と直交する平面に対して、 $\tan^{-1}(2^{1/2})$ (約54.74°)の角度を形成していれば、DC領域においても感度を有するサーボ加速度計の重力加速度Gを利用した感度校正を行うと、次のような重力加速度Gの成分が各軸加速度センサ5、6、7に作用する。

【0037】重力加速度Gを980Galとすると、Z軸加速度センサ7に作用する重力加速度Gの成分は、 $980 \times \sin(54.74^\circ) = 800$ となり、X軸加速度センサ5とY軸加速度センサ6に作用する重力加速度Gの成分は、 $980 \times \cos(54.74^\circ) \times \cos(45^\circ) = 400$ となる。即ち、X軸加速度センサ5とY軸加速度センサ6には、400Gal、Z軸加速度センサ7には、800Galという切りのよい重力加速度Gの成分が作用することになる。

【0038】従って、重力加速度G及び加振装置の加速

度Aを利用した感度校正が、3軸加速度計14の校正用治具への取付作業を1回だけ行うことにより実施することができる。

【0039】重力加速度Gを利用して3軸加速度計4の感度校正を行う場合でも、加振装置を利用して3軸加速度計14の感度校正を行う場合でも、加速度方向に対して角度が、 $\tan^{-1}(2^{1/2})$ (約35.26°)となる取付面に、前記の如く3軸加速度計4、14を固定すれば、X・Y・Zの各軸加速度センサ5、6、7に同一の加速度成分(重力加速度G又は加速度Aの約57.7%)が作用する。

【0040】また、重力加速度Gを利用して3軸加速度計4の感度校正を行う場合でも、加振装置を利用して3軸加速度計14の感度校正を行う場合でも、ブロック2、12は、同一の形状に形成することができるので、基台1の上面1a又は加振台13への載置又は固定の仕方により共用化することができる。

【0041】即ち、直角三角形であるブロック2、12の上面2a、12aの35.26°の頂角が対向する側面を基台1の上面1aに接して、ブロック2を基台1の上面1aに載置すれば、重力加速度Gを利用した3軸加速度計4の感度校正が行える。一方、54.74°の頂角が対向する側面を加振台13に接して、ブロック2を加振台13に固定すれば、加振装置を利用した3軸加速度計14の感度校正が行える。

【0042】また、図1に示す3軸加速度計校正用治具を用いて3軸加速度計4の感度校正を行う場合に、垂直方向の加振装置に校正用治具を固定して重力加速度方向に加振すれば、3軸加速度計4の校正用治具への取付作業を1回だけ行うことにより、重力加速度G及び加振装置の加速度を利用した感度校正を行うことができる。

【0043】また、X・Y・Zの各軸加速度センサ5、6、7の感度校正が、既に各軸単独で行われている3軸加速度計4、14の場合には、本発明に係る3軸加速度計校正用治具を用いて感度校正を行うことにより、各軸加速度センサ5、6、7の組付精度を知ることが可能になる。

【0044】また、X・Y・Zの各軸に極性のある加速度センサを使用すれば、各加速度センサの出力信号の位相関係から加速度センサの取付状態のチェックを行える。

【0045】

【発明の効果】以上説明したように本発明によれば、3軸加速度計を校正用治具の取付面に固定すれば、3軸加速度計の感度校正を3軸同時に行うことができるので、3軸加速度計の校正用治具への取付作業が1回で済み、3軸加速度計の感度校正の迅速化が図れる。

【図面の簡単な説明】

【図1】請求項1の発明に係る3軸加速度計校正用治具の斜視図

* び平行な加速度成分を示す図、(b)は3軸加速度計の取付面に平行な加速度成分のX・Y軸への分解状態を示す図

【符号の説明】

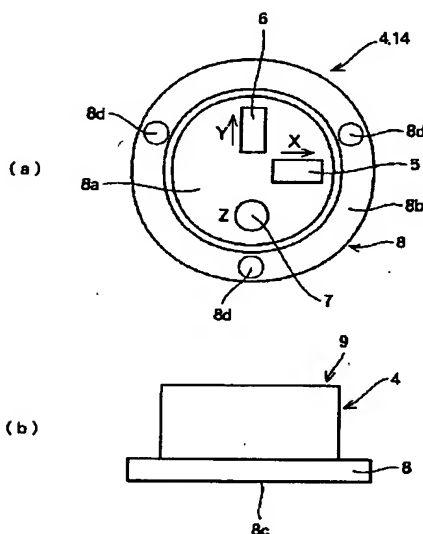
1, 11…基台、1a, 11a…基台の上面、2, 12…ブロック、2a, 12a…ブロックの上面、2b, 12b…取付面、3…水準器、4, 14…3軸加速度計、5…X軸加速度センサ、5a…X方向受感軸、6…Y軸加速度センサ、6a…Y方向受感軸、7…Z軸加速度センサ、7a…Z方向受感軸、13…加振台、14…固定用ねじ。

10

用ねじ。

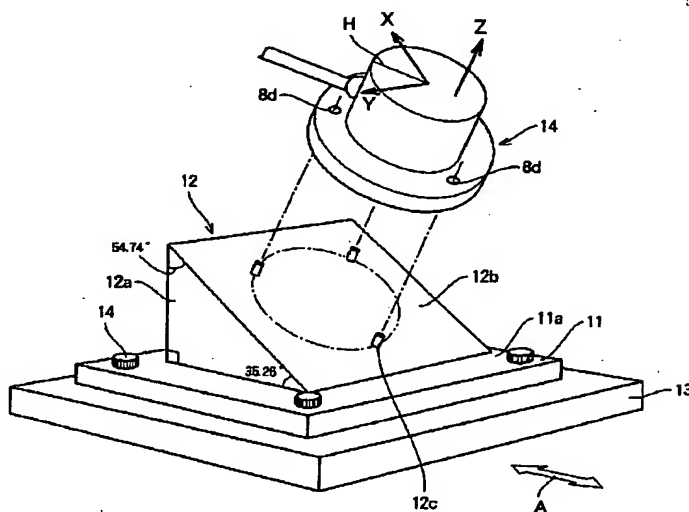
用ねじ。

【図2】

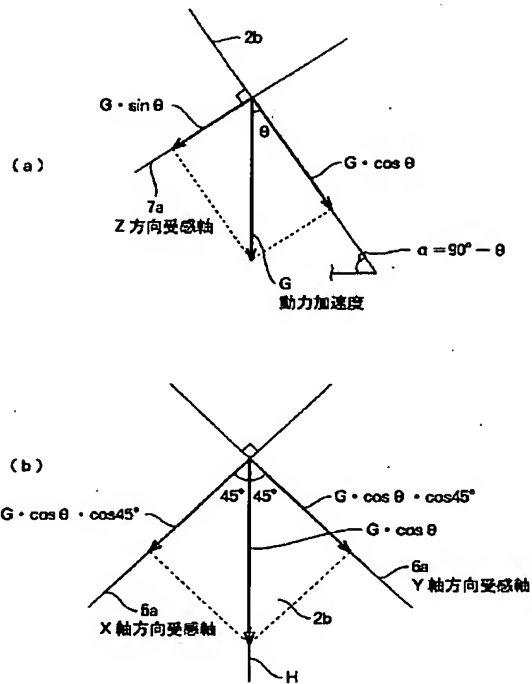


【図4】

【图5】



【図3】



【図6】

